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**APPLICATION
FOR
UNITED STATES LETTERS PATENT**

TITLE: TEXTURIZED FIBROUS MATERIALS FROM POLY-COATED
PAPER AND COMPOSITIONS AND COMPOSITES MADE
THEREFROM

APPLICANT: MARSHALL MEDOFF; ARTHUR LAGACE

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Francisco Robles

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TEXTURIZED FIBROUS MATERIALS FROM POLY-COATED PAPER
AND COMPOSITIONS AND COMPOSITES MADE THEREFROM

5 Cross Reference to Related Applications

 This application is a continuation-in-part of U.S.
Patent Application Serial No. 08/921,807, filed September 2,
1997.

Background of the Invention

10 The invention relates to texturized fibrous
materials prepared from poly-coated paper, and compositions
and composites made from such materials.

 Paper coated with a polymer (poly-coated paper) is
used in a number applications. For example, poly-coated
15 paper is used to make a variety of food containers,
including individual-serving size juice cartons and boxes
for frozen foods.

Summary of the Invention

 In general, the invention features texturized poly-
20 coated paper and compositions and composites made therefrom.

 In one embodiment, the invention features a process
for preparing a texturized fibrous material. The process
includes shearing poly-coated paper having internal fibers,
to the extent that the internal fibers are substantially
25 exposed, resulting in a texturized fibrous material. The
poly-coated paper can, for example, be made of polyethylene
and paper, and, in some cases, one or more layers of
aluminum. The exposed fibers of the texturized fibrous
material can have a length/diameter (L/D) ratio of at least
30 about 5 (e.g., at least about 5, 10, 25, 50, or more). For
example, at least about 50% of the fibers can have L/D
ratios of this magnitude.

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5 In another embodiment, the invention features a
texturized fibrous material that includes poly-coated paper
having internal fibers, where the poly-coated paper is
sheared to the extent that the internal fibers are
substantially exposed.

10 The texturized fibrous material can, for example, be
incorporated into (e.g., associated with, blended with,
adjacent to, surrounded by, or within) a structure or
carrier (e.g., a netting, a membrane, a flotation device, a
bag, a shell, or a biodegradable substance). Optionally,
the structure or carrier may itself be made from a
texturized fibrous material (e.g., a texturized fibrous
material of the invention), or of a composition or composite
of a texturized fibrous material.

15 The texturized fibrous material can have a bulk
density less than about 0.5 grams per cubic centimeter
(g/cm³), or even less than about 0.2 g/cm³.

20 Compositions that include the texturized fibrous
materials described above, together with a chemical or
chemical formulation (e.g., a pharmaceutical such as an
antibiotic or contraceptive, optionally with an excipient;
an agricultural compound such as a fertilizer, herbicide, or
pesticide; or a formulation that includes enzymes) are also
within the scope of the invention, as are compositions that
25 include the texturized fibrous materials and other liquid or
solid ingredients (e.g., particulate, powdered, or
granulated solids such as plant seed, foodstuffs, or
bacteria).

30 Composites that include thermoplastic resin and the
texturized fibrous materials are also contemplated. The
resin can be, for example, polyethylene, polypropylene,
polystyrene, polycarbonate, polybutylene, a thermoplastic
polyester, a polyether, a thermoplastic polyurethane,

polyvinylchloride, or a polyamide, or a combination of two or more resins.

In some cases, at least about 5% by weight (e.g., 5%, 10%, 25%, 50%, 75%, 90%, 95%, 99%, or about 100%) of the fibrous material included in the composites is texturized.

The composite may include, for example, about 30% to about 70% by weight resin and about 30% to about 70% by weight texturized fibrous material, although proportions outside of these ranges may also be used.

The composites can also, optionally, include lignocellulosic fiber (e.g., wood or derivatives of trees or other plants) or cellulosic fiber (e.g., paper or paper products).

The composites can be quite strong, in some cases having a flexural strength of at least about 6,000 to 10,000 psi.

The composites can also include inorganic additives such as calcium carbonate, graphite, asbestos, wollastonite, mica, glass, fiber glass, chalk, talc, silica, ceramic, ground construction waste, tire rubber powder, carbon fibers, or metal fibers (e.g., stainless steel or aluminum). The inorganic additives can represent about 0.5% to about 20% of the total weight of the composite.

The composite can be in the form of, for example, a pallet (e.g., an injection molded pallet), pipes, panels, decking materials, boards, housings, sheets, poles, straps, fencing, members, doors, shutters, awnings, shades, signs, frames, window casings, backboards, wallboards, flooring, tiles, railroad ties, forms, trays, tool handles, stalls, bedding, dispensers, staves, films, wraps, totes, barrels, boxes, packing materials, baskets, straps, slips, racks, casings, binders, dividers, walls, indoor and outdoor carpets, rugs, wovens, and mats, frames, bookcases,

sculptures, chairs, tables, desks, art, toys, games,
wharves, piers, boats, masts, pollution control products,
septic tanks, automotive panels, substrates, computer
housings, above- and below-ground electrical casings,
5 furniture, picnic tables, tents, playgrounds, benches,
shelters, sporting goods, beds, bedpans, thread, filament,
cloth, plaques, trays, hangers, servers, pools, insulation,
caskets, bookcovers, clothes, canes, crutches, and other
construction, agricultural, material handling,
10 transportation, automotive, industrial, environmental,
naval, electrical, electronic, recreational, medical,
textile, and consumer products. The composites can also be
in the form of a fiber, filament, or film.

The terms "texturized poly-coated paper" and
15 "texturized fibrous material", as used herein, mean that the
poly-coated paper has been sheared to the extent that its
internal fibers are substantially exposed. At least about
50%, more preferably at least about 70%, of these fibers, as
well as the external polymer fibers, have a length/diameter
20 (L/D) ratio of at least 5, more preferably at least 25, or
at least 50. An example of texturized poly-coated paper is
shown in Fig. 1.

The texturized fibrous materials of the invention
have properties that render them useful for various
25 applications. For example, the texturized fibrous materials
have absorbent properties, which can be exploited, for
example, for pollution control. The fibers are generally
biodegradable, making them suitable, for example, for drug
or chemical delivery (e.g., in the treatment of humans,
30 animals, or in agricultural applications). The texturized
fibrous materials can also be used to reinforce polymeric
resins.

Those composites that include texturized fibrous material and resin are strong, light-weight, and inexpensive. The raw materials used to make the composites are available as virgin or recycled materials; for example, they may include discarded containers composed of resins, and discarded containers composed of poly-coated paper.

Poly-coated paper can be difficult to recycle because the paper and the polymer layers generally cannot be separated. In the present invention, both the paper and the polymer portions are utilized, so there is no need to separate the two. Poly-coated paper including one or more layers of aluminum can similarly be used. The invention thus helps to recycle discarded post-consumer containers, while at the same time producing useful products.

Other features and advantages of the invention will be apparent from the following detailed description, and from the claims.

Brief Description of the Drawing

Fig. 1 is a photograph of texturized poly-coated paper, magnified 50 times.

Fig. 2 is a photograph of a half-gallon polyboard juice carton.

Fig. 3 is a photograph of shredded half-gallon polyboard juice cartons.

Fig. 4 is a photograph of texturized fibrous material prepared by shearing the shredded half-gallon polyboard juice cartons of Fig. 3.

Detailed Description of the Invention

Poly-coated paper is available in a variety of forms. For example, whole sheets of virgin poly-coated paper can be purchased from International Paper, New York.

Alternatively, virgin waste poly-coated paper (e.g., ,edge trimmings, surplus, misprinted stock) can be obtained from International Paper or other paper manufacturers. Used poly-coated paper, in the form of discarded food and beverage containers, can be gathered from various sources, including waste and recycling streams. Poly-coated paper that includes one or more layers of aluminum foil as is commonly used for airtight liquid storage, may also be used. Used, waste, or scrap poly-coated paper (e.g., post-consumer waste, industrial offal) can also be purchased from brokers of this material.

Preparation of the Texturized Fibrous Material

If scrap poly-coated paper is used, it should be clean and dry. The poly-coated paper can be texturized using any one of a number of mechanical means, or combinations thereof. During the texturizing process, the polymer layers are sheared away from the paper layers, thus exposing the paper fibers. A preferred method of texturizing includes first cutting the poly-coated paper into 1/4- to 1/2-inch pieces, if necessary, using a standard paper-cutting apparatus. Counter-rotating screw shredders and segmented rotating screw shredders such as those manufactured by Munson (Utica, NY) can also be used, as can a standard document shredder as found in many offices.

The paper is then sheared with a rotary cutter, such as the one manufactured by Sprout, Waldron Companies, as described in Perry's Chem. Eng. Handbook, 6th Ed., at 8-29 (1984). Although other settings can be used, the spacing between the rotating knives and bed knives of the rotary cutter is typically set to 0.020" or less, and blade rotation is set to 750 rpm or more. The rotary cutter can

be cooled to 100°C or lower during the process, for example, using a water jacket.

The texturized material is passed through a discharge screen. Larger screens (e.g., up to 6 mm) can be used in large-scale production. The poly-coated paper feedstock is generally kept in contact with the blades of the rotary cutter until the fibers are pulled apart; smaller screens (e.g., 2 mm mesh) provide longer residence times and more complete texturization, but can result in lower length/diameter (L/D) aspect ratios. A vacuum drawer can be attached to the screen to maximize and maintain fiber length/diameter aspect ratio.

The texturized fibrous material can be directly stored in sealed bags or may be dried at approximately 105°C for 4-18 hours (e.g., until the moisture content is less than about 0.5%) immediately before use. Fig. 1 is an SEM photograph of the texturized poly-coated paper.

Alternative texturizing methods include stone grinding, mechanical ripping or tearing, and other methods whereby the paper's internal fibers can be exposed (e.g., pin grinding, air attrition milling).

Uses of Texturized Fibrous Material

Texturized fibrous material and compositions of such materials with other chemicals and chemical formulations can be prepared to take advantage of the material's properties. The materials can be used to absorb chemicals, for example, potentially absorbing many times their own weight. Thus, the material could, for instance, be used to absorb spilled oil, or for clean-up of environmental pollution, for example, in water, in the air, or on land. Similarly, the material's absorbent properties, together with its biodegradability, also make them useful for delivery of

chemicals or chemical formulations. For example, the materials can be treated with solutions of enzymes or pharmaceuticals such as antibiotics, nutrients, or contraceptives, and any necessary excipients, for drug
5 delivery (e.g., for treatment of humans or animals, or for use as or in animal feed and/or bedding), as well as with solutions of fertilizers, herbicides, or pesticides. The texturized fibrous materials can optionally be chemically treated to enhance a specific absorption property. For
10 example, the materials can be treated with silanes to render them lipophilic.

Compositions including texturized materials combined with liquids or particulate, powdered, or granulated solids can also be prepared. For example, the texturized fibrous
15 materials can be blended with seeds (i.e., with or without treatment with a solution of fertilizer, pesticides, etc.), foodstuffs, or bacteria (e.g., bacteria that digest toxins). The ratio of fibrous material to the other components of the compositions will depend on the nature of the components and
20 readily be adjusted for a specific product application.

In some cases, it may be advantageous to associate the texturized fibrous materials, or compositions or composites of such materials, with a structure or carrier such as a netting, a membrane, a flotation device, a bag, a
25 shell, or a biodegradable substance. Optionally, the structure or carrier may itself be made of a texturized fibrous material (e.g., a material of the invention), or a composition or composite thereof.

Composites of Texturized Fibrous Material and Resin

30 Texturized fibrous materials can also be combined with resins to form strong, lightweight composites. Materials that have been treated with chemicals or chemical

formulations, as described above, can similarly be combined with biodegradable or non-biodegradable resins to form composites, allowing the introduction of, for example, hydrophilic substances into otherwise hydrophobic polymer matrices. Alternatively, the composites including texturized fibrous materials and resin can be treated with chemicals or chemical formulations.

The texturized poly-coated paper provides the composite with strength. The composite may include from about 10% to about 90%, more preferably from about 30% to about 70%, of the texturized poly-coated paper by weight. Examples of poly-coated paper include materials having layers of polymer and paper, and materials having layers of polymer, paper, and aluminum.

The resin encapsulates the texturized poly-coated paper and helps control the shape of the composites. The resin also transfers external loads to the poly-coated paper and protect the poly-coated paper from environmental and structural damage. Composites include, for example, about 10% to about 90%, more preferably about 30% to about 70%, by weight, of the resins.

Examples of resins include polyethylene (including, e.g., low density polyethylene and high density polyethylene), polypropylene, polystyrene, polycarbonate, polybutylene, thermoplastic polyesters, polyethers, thermoplastic polyurethane, PVC, polyamides (e.g., nylon), and other resins. It is preferred that the resins have a low melt flow index. Preferred resins include polyethylene and polypropylene with melt flow indices of less than 3 g/10 min, and more preferably less than 1 g/10 min.

The resins can be purchased as virgin material, or obtained as waste materials, and can be purchased in pelletized or granulated form. One source of resin is used

polyethylene milk bottles. If surface moisture is present on the pelletized or granulated resin, however, it should be dried before use.

The composites can also include coupling agents.

- 5 The coupling agents help to bond the hydrophilic fibers of the poly-coated paper to the hydrophobic resins. Examples of coupling agents include maleic anhydride modified polyethylenes, such those in the FUSABOND® (available from Dupont, Delaware) and POLYBOND® (available from Uniroyal
- 10 Chemical, Connecticut) series. One suitable coupling agent is a maleic anhydride modified high density polyethylene such as FUSABOND® MB 100D.

- The composites can also include other cellulosic or lignocellulosic fibers such as paper and paper products,
- 15 wood, wood fibers, and wood-related materials, as well as materials derived from kenaf, grasses, rice hulls, bagasse, cotton, and jute. These fibers provide extra strength to the composite.

- The quantity of fiber which is incorporated into the
- 20 composites can vary, depending on the desired physical and mechanical properties of the finished products. Preferred composites contain about 5% to about 50%, more preferably about 10% to about 30%, by weight of the cellulosic or lignocellulosic fiber. The fibers may have, for example, a
- 25 L/D ratio of at least 5, or at least 25 or 50. If cellulosic or lignocellulosic fibers are used, they can be texturized, using the process described above.

- The composites can also contain additives known to those in the art of compounding, such as plasticizers,
- 30 lubricants, antioxidants, opacifiers, heat stabilizers, colorants, impact modifiers, photostabilizers, flame retardants, biocides, and antistatic agents.

5 The composites can also include inorganic additives
such as calcium carbonate, graphite, asbestos, wollastonite,
mica, glass, fiber glass, chalk, silica, talc, ceramic,
ground construction waste, tire rubber powder, carbon
fibers, or metal fibers (e.g., aluminum, stainless steel).
When such additives are included, they are typically present
in quantities of from about 0.5% up to about 20-30% by
weight. For example, submicron calcium carbonate can be
added to the composites of texturized fibrous material and
10 resin to improve impact modification characteristics or to
enhance composite strength.

Preparation of Compositions

15 Compositions containing the texturized cellulosic or
lignocellulosic materials and chemicals, chemical
formulations, or other solids can be prepared, for example,
in various immersion, spraying, or blending apparatuses,
including, but not limited to, ribbon blenders, cone
blenders, double cone blenders, and Patterson-Kelly "V"
blenders.

20 For example, a composition containing 90% by weight
texturized cellulosic or lignocellulosic material and 10% by
weight ammonium phosphate or sodium bicarbonate can be
prepared in a cone blender to create a fire-retardant
material for absorbing oil.

Preparation of Composites of Texturized Fibrous Material and Resin

25 Composites of texturized poly-coated paper and resin
can be prepared as follows. A standard rubber/plastic
compounding 2-roll mill is heated to 325-400°F. The resin
30 (usually in the form of pellets or granules) is added to the
heated roll mill. After about 5 to 10 minutes, the coupling

agent is added to the roll mill. After another five minutes, the texturized poly-coated paper is added to the molten resin/coupling agent mixture. The texturized poly-coated paper is added over a period of about 10 minutes.

5 The composite is removed from the roll mill, cut into sheets and allowed to cool to room temperature. It is then compression molded into plaques using standard compression molding techniques.

10 Alternatively, a mixer, such as a Banbury internal mixer, is charged with the ingredients. The ingredients are mixed, while the temperature is maintained at less than about 190°C. The mixture can then be compression molded.

15 In another embodiment, the ingredients can be mixed in an extruder mixer, such as a twin-screw extruder equipped with co-rotating screws. The resin and the coupling agent are introduced at the extruder feed throat; the texturized poly-coated paper (and cellulosic or lignocellulosic fiber, if used) are introduced about 1/3 of the way down the length of the extruder into the molten resin. The internal
20 temperature of the extruder is maintained at less than about 190°C. At the output, the composite can be, for example, pelletized by cold strand cutting.

Alternatively, the mixture can first be prepared in a batch mixer, then transferred to an extruder.

25 In another embodiment, the composite can be formed into filaments for knitting, warping, weaving, and braiding, and to make non-wovens. In a further embodiment, the composite can be made into film.

30 Properties of the Composites of Texturized Fibrous Material and Resin

The resulting composites include a network of fibers, encapsulated within a resin matrix. The fibers form

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a lattice network, which provides the composite with strength. Since the poly-coated paper is texturized, the amount of surface area available to bond to the resin is increased, in comparison to composites prepared with un-
5 texturized poly-coated paper. The resin binds to the surfaces of the exposed fibers, creating an intimate blend of the fiber network and the resin matrix. The intimate blending of the fibers and the resin matrix further strengthens the composites. Cellulosic or lignocellulosic
10 fibers may also be added to strengthen the composite further.

Uses of the Composites of Texturized Fibrous Material and Resin

The poly-coated paper/resin composites can be used
15 in a number of applications. The composites are strong and light weight; they can be used, for example, as wood substitutes. The resin coating renders the composites water-resistant, so they may be used in outdoor applications. For example, the composites may be used to
20 make pallets which are stored outdoors for extended periods of time, wine staves, rowboats, furniture, skis, and oars. Many other uses are contemplated, including pipes, panels, decking materials, boards, housings, sheets, poles, straps, fencing, members, doors, shutters, awnings, shades, signs,
25 frames, window casings, backboards, wallboards, flooring, tiles, railroad ties, forms, trays, tool handles, stalls, bedding, dispensers, staves, films, wraps, totes, barrels, boxes, packing materials, baskets, straps, slips, racks, casings, binders, dividers, walls, indoor and outdoor
30 carpets, rugs, wovens, and mats, frames, bookcases, sculptures, chairs, tables, desks, art, toys, games, wharves, piers, boats, masts, pollution control products,

septic tanks, automotive panels, substrates, computer housings, above- and below-ground electrical casings, furniture, picnic tables, tents, playgrounds, benches, shelters, sporting goods, beds, bedpans, thread, filament, cloth, plaques, trays, hangers, servers, pools, insulation, caskets, bookcovers, clothes, canes, crutches, and other construction, agricultural, material handling, transportation, automotive, industrial, environmental, naval, electrical, electronic, recreational, medical, textile, and consumer products. Numerous other applications are also envisioned. The composites may also be used, for example, as the base or carcass for a veneer product. Moreover, the composites can be, for example, surface treated, grooved, milled, shaped, imprinted, textured, compressed, punched, or colored. The surface of the composites can be smooth or rough.

The following examples illustrate certain embodiments and aspects of the present invention and not to be construed as limiting the scope thereof.

Examples

Example 1

A 1500 pound skid of virgin, half-gallon juice cartons made of poly-coated white kraft board was obtained from International Paper. One such carton is shown in Fig. 2. Each carton was folded flat.

The cartons were fed into a 3 hp Flinch Baugh shredder at a rate of approximately 15 to 20 pounds per hour. The shredder was equipped with two rotary blades, each 12" in length, two fixed blades, and a 0.3" discharge screen. The gap between the rotary and fixed blades was 0.10".

A sample of the output from the shredder, consisting primarily of confetti-like pieces, about 0.1" to 0.5" in width and about 0.25" to 1" in length, is shown in Fig. 3.

The shredder output was then fed into a Thomas Wiley
5 Mill Model 2D5 rotary cutter. The rotary cutter had four rotary blades, four fixed blades, and a 2 mm discharge screen. Each blade was approximately 2" long. The blade gap was set at 0.020".

The rotary cutter sheared the confetti-like pieces
10 across the knife edges, tearing the pieces apart and releasing a finely texturized fiber at a rate of about one pound per hour. The fiber had an average minimum L/D ratio of between five and 100 or more. The bulk density of the texturized fiber was on the order of 0.1 g/cm₃. A sample of
15 texturized fiber is shown in Fig. 4 at normal magnification, and in Fig. 1 at fifty-fold magnification.

Example 2

Composites of texturized poly-coated paper and resin
were prepared as follows. A standard rubber/plastic
20 compounding 2-roll mill was heated to 325-400°F. The resin (usually in the form of pellets or granules) was added to the heated roll mill. After about 5 to 10 minutes, the resin banded on the rolls (i.e., it melted and fused on the rolls). The coupling agent was then added to the roll mill.
25 After another five minutes, the texturized poly-coated paper was added to the molten resin/coupling agent mixture. The poly-coated paper was added over a period of about 10 minutes.

The composite was then removed from the roll mill,
30 cut into sheets, and allowed to cool to room temperature. Batches of about 80 g each were compression molded into 6" x

6" x 1/8" plaques using standard compression molding techniques.

One composition contains the following ingredients:

Composition No. 1

5	<u>Ingredient</u>	<u>Amount (g)</u>
	High density polyethylene ¹	160
	Poly-coated paper ²	240
	Coupling agent ³	8

10 ¹ Marlex 6007, melt flow index 0.65 g/10 min, commercially available from Phillips

² Texturized using rotary cutter with 2 mm mesh

³ POLYBOND® 3009, commercially available from Uniroyal Chemical

15 The plaques were machined into appropriate test specimens and tested according to the procedures outlined in the method specified. Three different specimens were tested for each property, and the mean value for each test was calculated.

The properties of Composition No. 1 are as follows:

20	Tensile modulus (10 ⁵ psi)	8.63 (ASTM D638)
	Tensile strength at break (psi)	6820 (ASTM D638)
	Ultimate elongation (%)	<5 (ASTM D638)
	Flexural Strength (psi)	12,200 (ASTM D790)
	Flexural modulus (10 ⁵ psi)	6.61 (ASTM D790)

25 A second composition contains the following ingredients:

Composition No. 2

	<u>Ingredient</u>	<u>Amount (g)</u>
	High density polyethylene ¹	160
30	Poly-coated paper ²	240
	Coupling agent ³	8

¹ Scrapped milk jugs, melt flow index approximately 0.8 g/10 min

² Texturized using rotary cutter with 2 mm mesh

³ POLYBOND® 3009

5 The properties of Composition No. 2 are as follows:

Tensile modulus (10 ⁵ psi)	7.38 (ASTM D638)
Tensile strength at break (psi)	6500 (ASTM D638)
Ultimate elongation (%)	<5 (ASTM D638)
Flexural Strength (psi)	11,900 (ASTM D790)
10 Flexural modulus (10 ⁵ psi)	6.50 (ASTM D790)

A third composition contains the following ingredients:

Composition No. 3

<u>Ingredient</u>	<u>Amount (g)</u>
15 High density polyethylene ¹	160
Poly-coated paper ²	240
Coupling agent ³	8

¹ Scrap milk jugs, melt flow index approximately 0.8 g/10 min

20 ² Texturized using rotary cutter with 2 mm mesh

³ FUSABOND® MB 100D, commercially available from DuPont

The properties of Composition No. 3 are as follows:

Tensile modulus (10 ⁵ psi)	7.08 (ASTM D638)
Tensile strength at break (psi)	6480 (ASTM D638)
25 Ultimate elongation (%)	<5 (ASTM D638)
Flexural Strength (psi)	10,200 (ASTM D790)
Flexural modulus (10 ⁵ psi)	5.73 (ASTM D790)

A fourth composition contains the following ingredients:

Composition No. 4

<u>Ingredient</u>	<u>Amount (g)</u>
5 High density polyethylene ¹	160
Poly-coated paper ²	240
Coupling agent ³	8

¹ Marlex 6007, melt flow index 0.65 g/10 min

² texturized using rotary cutter with 2 mm mesh

10 ³ FUSABOND® MB 100D

The properties of Composition No. 4 are as follows:

Tensile modulus (10 ⁵ psi)	7.17 (ASTM D638)
Tensile strength at break (psi)	6860 (ASTM D638)
Ultimate elongation (%)	<5 (ASTM D638)
15 Flexural Strength (psi)	12,200 (ASTM D790)
Flexural modulus (10 ⁵ psi)	7.50 (ASTM D790)

A fifth composition contains the following ingredients:

Composition No. 5

20 <u>Ingredient</u>	<u>Amount (g)</u>
SUPERFLEX™ CaCO ₃	33
Fiber ^{2,4}	67
HDPE (w/3% compatibilizer) ^{1,3}	100

⁴ virgin poly-coated milk cartons

25 The properties of Composition No. 5 are as follows:

Flexural strength (10 ⁵ psi)	8.29 (ASTM D790)
Ultimate elongation (%)	<5 (ASTM D638)
Flexural modulus (10 ⁵ psi)	10.1 (ASTM D790)
Notch Izod (ft-lb/in)	1.39 (ASTM D256-97)

30 A sixth composition contains the following ingredients:

Composition No. 6

	<u>Ingredient</u>	<u>Amount (parts)</u>
	SUPERFLEX™ CaCO ₃	22
	Fiber ^{2,4}	67
5	HDPE (w/3% compatibilizer) ^{1,3}	100

The properties of Composition No. 6 are as follows:

	Flexural strength (10 ⁵ psi)	8.38 (ASTM D790)
	Ultimate elongation (%)	< 5 (ASTM D638)
	Flexural modulus (10 ⁵ psi)	9.86 (ASTM D790)
10	Notch Izod (ft-lb/in)	1.37 (ASTM D256-97)

A seventh composition contains the following ingredients:

Composition No. 7

	<u>Ingredient</u>	<u>Amount (parts)</u>
15	ULTRAFLEX™ CaCO ₃	33
	Fiber ^{2,4}	67
	HDPE/compatibilizer ^{1,3}	100

The properties of Composition No. 7 are as follows:

	Flexural strength (10 ⁵ psi)	7.43 (ASTM D790)
20	Ultimate elongation (%)	< 5 (ASTM D638)
	Flexural modulus (10 ⁵ psi)	11.6 (ASTM D790)
	Notch Izod (ft-lb/in)	1.27 (ASTM D256-97)

other embodiments are with the claims.

What is claimed is: